Research Paper | Engineering | E-ISSN No : 2454-9916 | Volume : 3 | Issue : 5 | May 2017

FEM ANALYSIS OF MOVABLE SHUTTLE HEAD MAIN FRAME FOR BULK MATERIAL HANDLING SYSTEM

Rajesh S. Badhe [1] | Dr. Rupa S. Bindu [2]

[1] PG Student of Mechanical Engg, SPPU University Pune, DYPIET, Pimpri Pune.
[2] Professor , Dept. Of Mechanical Engg., SPPU University Pune, DYPIET, Pimpri Pune.

ABSTRACT

This paper describes the use and benefits of Movable shuttle head over conventional chute arrangement for material transfer point between discharging and receiving conveyor.

In case of Movable Shuttle Head, with the command given from central control room, drive will position the shuttle head to respective conveyor feed point by forward/ reverse movement of shuttle on fixed rail in Junction house. Lesser height of material transfer intern lesser power consumption of feed conveyor and infrastructure cost and one conveyor can feed to multiple receiving conveyors are some of the Major benefits of Movable Shuttle Heads.

KEYWORDS: Bulk Material Handling (BMH), movable Shuttle head, Junction house, VVFD control.

1. INTRODUCTION:

All around the world, in sea-going and coastal vessels, different bulk materials are continuously being loaded or being unloaded from these vessels. In order to ensure a thriving international sea trade, for loading the material at the export terminal, unloading the vessels in the import terminal, for storing the material at the ports continuously and quickly, a high standard of perfection in port-handling methods is needed. The main applications of the Port BMH are conveying, stacking, reclaiming and blending of bulk materials, loading and unloading bulk materials, crushing, sizing and feeding of bulk materials often at rates more than 10000 tones per hour. A stockyard has a circular or longitudinal layout. It has an important function in the field of materials handling as it serves as material buffer, reserve or blended storage between incoming and outgoing materials. Due to the main functions of buffering, composing and homogenizing performed by a stockyard, a rightly designed / chosen system for this purpose, only, can balance out quality fluctuations. As the priorities for each application and stockyard operations are different, it is necessary to consider various aspects before selecting type and size of equipment. These aspects to be given due attention are: throughput required, characteristics of the materials to be handled, homogenizing effect required, open or roofed storage and future upgrading of the storage.

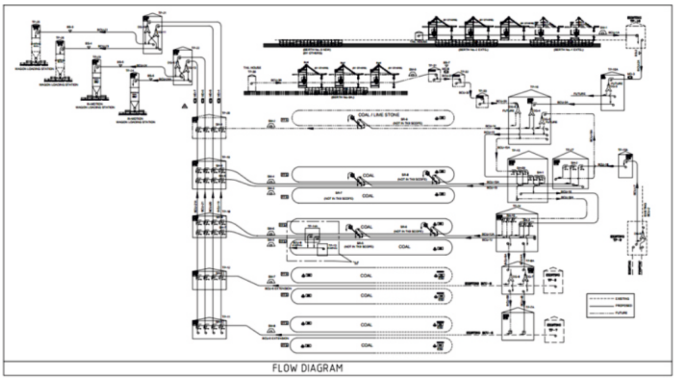

Fig.1: Flow diagram of typ. Port handling Plant

BMH equipment mainly comprises of:

- Reclaimers of bucket wheel boom type, bucket wheel bridge type, scraper type, drum type units.
- Stackers using different stacking methods like Chevron, Windrow and Cone Shell
- Combined stackers-reclaimers for bucket wheel or circular units
- Conveyers including transfer stations
- Mechanisied Wagon loading sytem.
- Wagon unloading system consists of wagon tippler, Side Arm Charger, underground hopper, and feeder below the hopper for evacuating the material unloaded into the hopper.
- Crushers, Screens etc.

2. CONVENTIONAL MATERIAL TRANSFER ARRANGEMENTS :

In conventional material transfer arrangement material from one conveyor to next conveyor is transferred through chute arrangement.

a. One conveyor to two conveyor Material transfer

This is widely used conventional arrangement of material transfer in which height of the building is larger to accommodate material transfer equipments i.e. Flap gates, Drive arrangement, Flap gate, chute arrangement & conveyor structure etc. Also the building structure made to be stronger to sustain wind loads, dead loads and live loads which are done reinforced columns. Schematic shown below is of one conveyor to two material transfers. Approximately heights of these types of buildings are 13-15m.

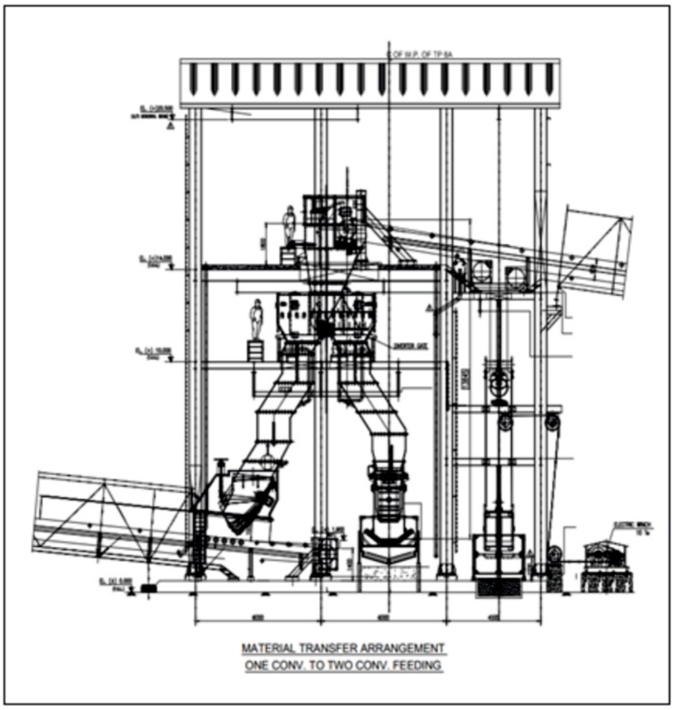

Fig.2: 1-2 Material transfer Arrangement

b. One conveyor to three conveyor Material Transfer Arrangement:

This is another traditional but less used arrangement. In this arrangement, height of building is highest as compare to the one conveyor to two conveyor material

Copyright© 2016, IERJ. This open-access article is published under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License which permits Share (copy and redistribute the material in any medium or format) and Adapt (remix, transform, and build upon the material) under the Attribution-NonCommercial terms.

transfer arrangement.

Approx. Height of the Building is 20-23 m. Its manufacturing cost is likely higher as compare other.

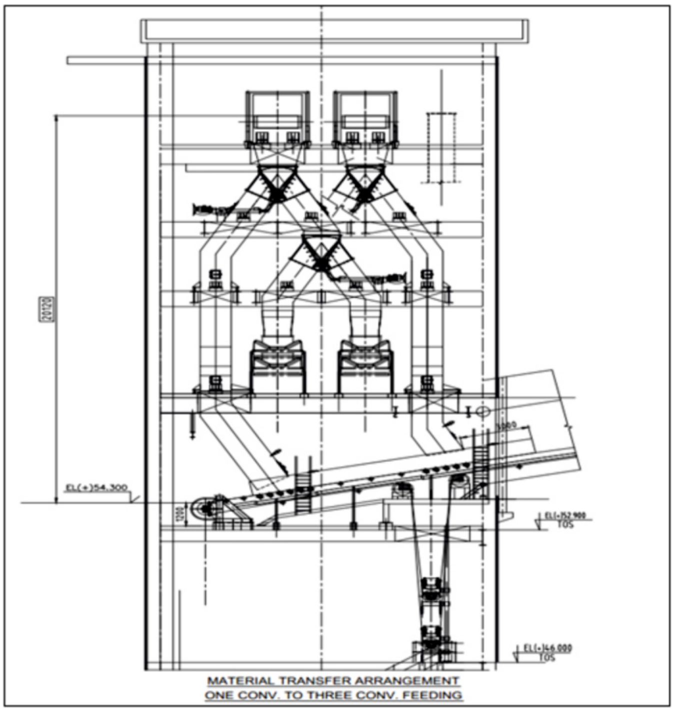

Fig.3: 1-3 Material transfer Arrangement

3. SHUTTLE HEAD ARRANGEMENT:

The bulk materials like coal, Iron ore, Lime stone etc. which are received from the ship are stored at dedicated stockpiles away from the port area. When material is brought to the port, it is unloaded by ship unloader and routed through various streams of conveyors to reach respective stockpile for storage. Thus a number of conveyors of long length are required from the unloading point at the ship to different stockpiles. Based on the requirement, central control room operator will decide whether unloaded coal from the ship will be stacked in the plant or it will be sent directly to rail loading silo through direct conveyor path.

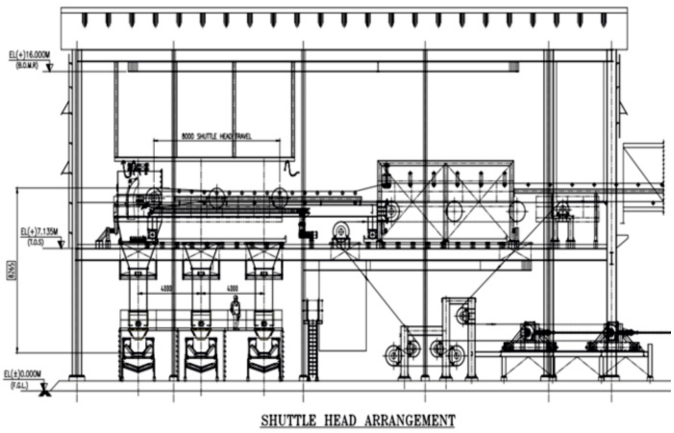

Fig.4: 1-3 Material transfer Arrangement by shuttle Head

The material which is unloaded from the ship is brought to the junction house by incoming conveyor belt. Shuttle head is located at head end of conveyor in junction house. This shuttle head travels on the rails above the floor surface. From the junction house, a number of outgoing conveyors, carry the material either to the stockpiles or to the railway loading silos. This change of conveyor path for the material is achieved with the help of shuttle head.

4. BENEFITS OF SHUTTLE HEAD:

1. One conveyor can feed to multiple receiving conveyors

2. Height of transfer tower is reduced.

3. Power consumption of feed conveyor is reduced.

4. Infrastructure cost is reduced.

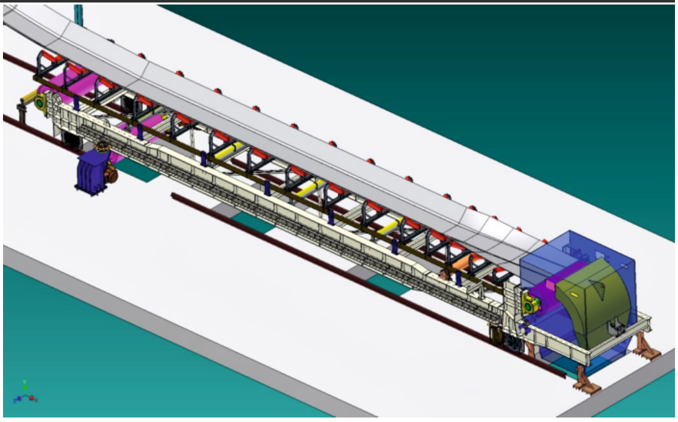

Fig. 5 Shuttle Head 3D- View

5. COMPARISON OF CONVENTIONAL (CHUTE TYPE) AND PROPOSED (SHUTTLE HEAD TYPE) MATERIAL TRANSFER ARRANGEMENT FOR 2200 MM BELT WIDTH

Table 1: Comparison in material transfer height

Conventional Material Transfer Arrangement	Transfer Height (m)	Shuttle Head Arrangement	Transfer Height (m)
One conv. discharges to two conv.	13.845	One conv. discharges to two conv.	8.265
One conv. discharges to Three conveyors	20.120	One conv. discharges to Three conv.	8.265

6. FEM ANALYSIS OF MAIN FRAME OF SHUTTLE HEAD:

6.1 Methodology

a. Design:

Dead Load & Live Load Calculations coming on the structural mainframe of the Movable Shuttle Head and Travel Drive calculations to be carried out.

These loads are as under:

i) Self weight of frame.
ii) Load of various components mounted on the frame.
iii) Material load.
iv) Belt tension.

b. Modeling & FEA analysis:

Preparation of 3-D model, using modeling software. Meshing, applying load and boundary condition. Then pre-processing is done using the material property, Load and Boundary condition. Using FEM software we get the stress and displacement results.

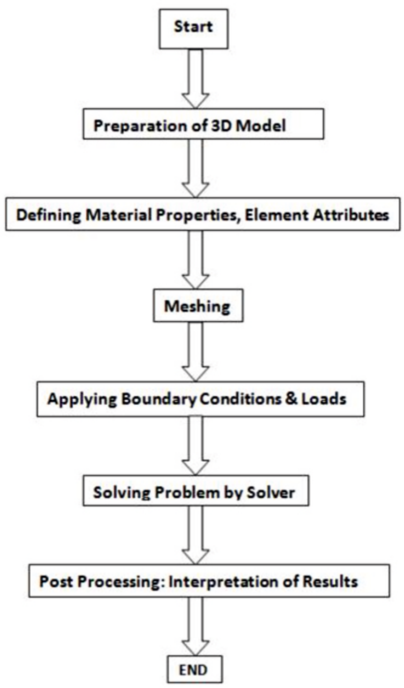

Fig.6 Flow Chart of FEM Analysis of structural mainframe of the movable shuttle head

6.2 3-D Model main frame

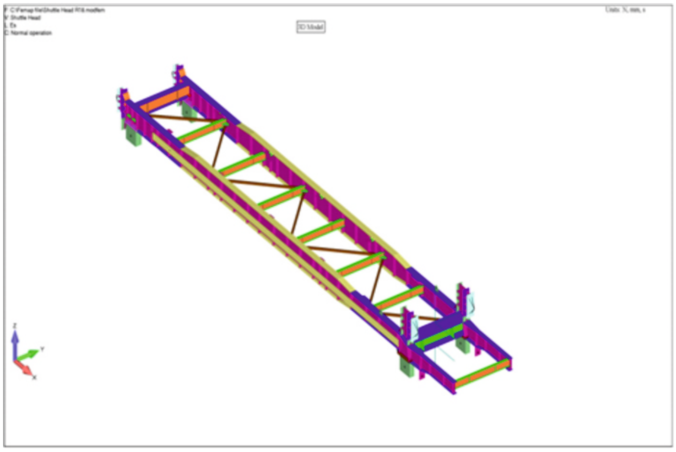

Fig.7 3 D View of the Mainframe of Shiftable Head

6.3 Application of loads on frame

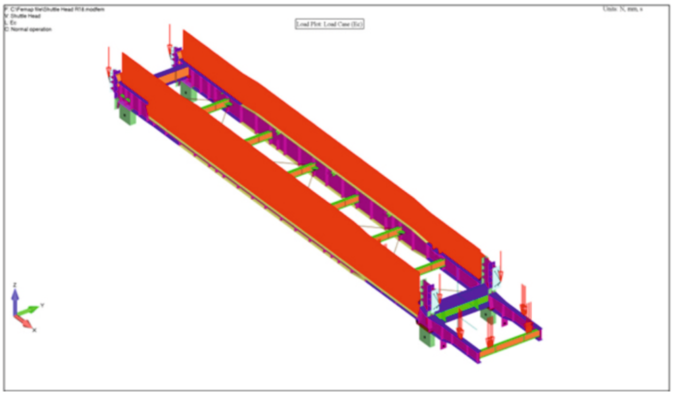

Fig. 8 Loads on Mainframe of Shiftable Head

6.5 Stress Plot

The wheel reactions are in upward direction. So there is no uplift at wheels and machine is stable.

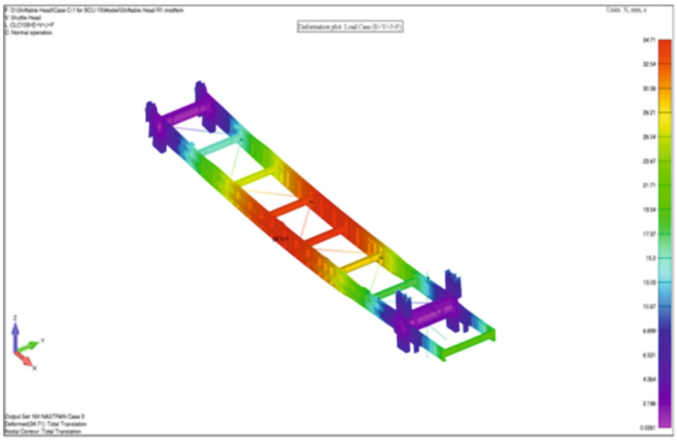

Fig 10 Deflection of Mainframe of Shiftable head

7. RESULT AND CONCLUSION OF FEM ANALYSIS

- **Stress:**

Material of construction: IS:2062 E250B

Yield Strength of selected material = 250.0 N/mm2

Max. VonMises stress from model = 130.3 N/mm2

Factor of safety = 1.5

Allowable VonMises stress = 166.7 N/mm2

It is observed that maximum stress is within the allowable limit for most unfavourable operating condition.

- **Deflection :**

Maximum deflection from analysis is 34.71 mm

SPAN (Wheel Base) = 20800 mm

Allowable Deflection = SPAN/500 = 41.6 mm

Deflection as per FEM analysis is 34.71 mm which is within the allowable limit of 41.6 mm.

As the drive pinion is mounted in horizontal plane and the rack rollers are in vertical position, the above deflection will not cause any problem to drive pinion/Rollers. So there will be no possibility of jamming of drive pinion.

- **Shiftable Head Stability:**

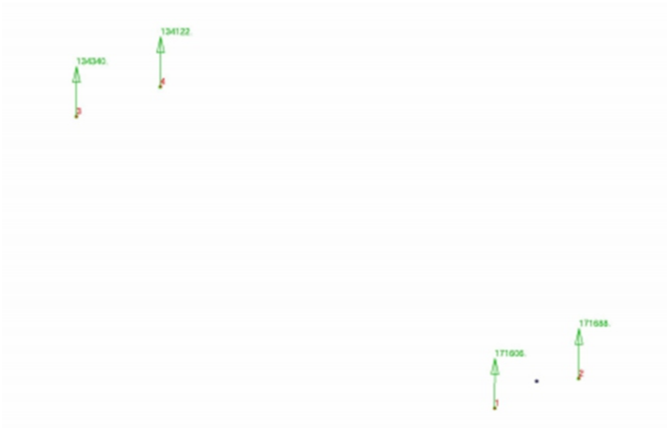

Fig.11 Shiftable Head Runner wheel

REFERENCES

1. Soon-Bok Lee, "Stress Analysis and Design for a Structural Fatigue testing Machine", ASME Journal, 1991, VOL No.2, PP. 115-124.
2. B. Denkena and C.Schmidt, "Experimental Investigation And Modeling of Thermal and Mechanical Influences on Shape Deviations in Machining Structural Parts, International Journal of Machine Tools & Manufacture", 2010, PP. 1015–1021.
3. Bi-Chu Wu and Gin-Shu Young , "Application of A Two-Level Optimization Process to Conceptual Structural Design of A Machine Tool" International Journal of Machine Tools & Manufacture", Vol 40 ,2000, 783–794.
4. M.I.M. Negm and M. M. Sadek, "Finite Element Prediction of Compliances of power plant Machine Structures and their Measured Correlation" , Int. J. Mach. Tool,1980, Vol. 20. PP. 9- 24
5. B. Malleswara Swami and K.Sunil Ratna Kumar, "Design and Structural Analysis of CNC Vertical Milling Machine Bed", Swami et al, International Journal of Advanced Engineering Technology, E-ISSN 0976-3945.
6. Magdi S. Mahmoud and Jafar A. Assiri, "Performance Analysis of Two-level Structures on Finite Precision Machines", Automatica, 1986 Vol. 22. No. 3, PP. 371 375.